How Do Conversational Agents in Healthcare Impact on Patient Agency?

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Abstract

In healthcare, agency refers to the ability of patients to actively participate in and control their health through collaborating with providers, informed decision-making and understanding health information. Conversational agents (CAs) are increasingly used for realizing digital health interventions, but it is still unclear how they are enhancing patient agency. This paper explores which technological components are required to enable CAs impacting on patient agency, and identifies metrics for measuring and evaluating this impact. We do this by drawing on existing work related to developing and evaluating healthcare CAs and through analysis of a concrete example of a CA. As a result, we identify five main areas where CAs enhance patient agency, namely by: improved access to health information, personalized advice, increased engagement, emotional support and reduced barriers to care. For each of these areas, specific technological functions have to be integrated into CAs such as sentiment and emotion analysis methods that allow a CA to support emotionally.

1 Introduction

In recent years, conversational agents (CAs) have gained significant attention in the healthcare industry for their potential to revolutionize patient care and empower individuals to take control of their health (Bates, 2019). These computer-based systems use artificial intelligence (AI) and natural language processing (NLP) to simulate human-like conversations and provide personalized support and information to patients. They can answer questions, provide medical information, remind patients of medication schedules (Tschanz et al., 2018), and even provide mental health support (Denecke et al., 2020b), all in a conversational format. This interaction model is particularly significant because it closely aligns with the natural human tendency to talk, making these tools both intuitive and effective for a wide range of patients. However, there is a need to explore by which technological components CAs are enabled to impact on patient agency and how this impact could be measured and evaluated. Incorporating this knowledge into the development of healthcare CA would help to ensure that patient agency can be positively impacted by the use of these systems.

Patient agency has been defined in different ways. Street et al. consider patient agency in the context of communication between patient and healthcare professional and define it as self-efficacy and empowerment (Street Jr et al., 2009). In contrast, O'Hair et al. rather consider the participatory aspect of patient agency and claim that "patient agency requires skills across the spectrum of participation in care, ranging from active participation in medical encounters and decision-making to self-care skills for managing everyday health-related activities" (O'Hair et al., 2003). Another perspective on agency is related to health literacy and the language of health information and patient-doctor interaction (Hunter et al., 2015).

By agency in healthcare we refer in this paper to the ability and empowerment of patients to actively participate, make informed decisions and exercise control over their health and healthcare. It includes the ability to access, understand and use health information, to engage in a collaborative decision-making process with healthcare providers, and to take proactive steps to manage their health and well-being (Bok et al., 2022). The importance of this issue is underscored by the evolving role of patients in their healthcare journey (Joseph et al., 2020).

This definition emphasizes the multifaceted nature of agency, highlighting not only the decision-making and self-management aspects, but also the critical role of understanding and engaging with health information, which is particularly relevant in

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the era of digital health solutions realized as CAs. Therefore, in the context of health CAs, agency refers to the extent to which these digital tools enhance or facilitate patient empowerment and involvement in their healthcare.

It is important to consider the agency of CAs in healthcare separately from traditional apps, as the interactive nature of conversations can make the experience more engaging and less passive. Navigation and interaction are very different. Many CAs are built with Artificial Intelligence and learn or adapt based on user interactions, allowing for more tailored and relevant responses over time, unlike static health apps. CAs can provide immediate feedback and answers to health-related questions, which is not always the case with other health apps that may require navigation through different sections to obtain information. CAs, especially those with well-designed personalities, can create a sense of connection and trust that is harder to achieve with standard health apps. They can handle more complex interactions, such as follow-up questions or clarifications, providing a deeper and more satisfying user experience. Advanced CAs can understand and respond to context, providing more relevant and personalized advice than traditional apps.

In previous work, we introduced a framework supposed to support evaluation and development of health CAs (Denecke, 2023). It comprises concrete metrics for evaluation, heuristics but also checklists that can be used during the CA development to ensure quality of the developed system. The aim of the current paper is to extend the framework by metrics to ensure that a health CA positively impacts on the patient agency. For this purpose, we will first answer the question on how a health CA can impact on patient agency. Then, we will assess how the existing framework covers the aspects of agency identified. Finally, we will collect metrics and checklists to be added to the framework to cover the facets of agency and measure agency.

2 Methods

In this paper, we answer the following research questions (RQ):

- RQ1: How do CAs impact on patient agency?
- RQ2: Which technology is needed to achieve the impact on agency?
- RQ3: How to evaluate the impact of the technology on agency?

To answer our research questions, we first identify aspects how CAs contribute to patients' agency. This will be done based on existing work related to the development and analysis of CAs in healthcare (Denecke et al., 2019; Gashi et al., 2021) and by reviewing literature on health CAs. Secondly, we collect the technological requirements that a CA must fulfill in order to ensure that the effects identified in the first step can be achieved, i.e. that a specific health CA can have an impact on the agency. This is done by analyzing an example of a health CA and mapping of the agency aspects from step 1 to technologies that are used to contribute to agency. In a third step, we evaluation categories ans metrics to allow researchers and developers to evaluate the impact of their CA on patient agency. Figure 1 summarizes the method and its results.

Hypothesizing that CAs implement specific technologies and functionalities to achieve an impact on the patient agency, an evaluation requires first to assess whether the technology needed to achieve an impact on agency is available in a CA with a required quality. Therefore, we map the development and evaluation framework proposed by Denecke et al. to the aspects of agency that have been identified in the first step (Denecke, 2023). The framework considers nine aspects from a general perspective (accessibility, ease of use, engagement, classifier performance, flexibility, content accuracy, context awareness, error tolerance, security), five aspects from a response generation perspective (appropriateness of responses, comprehensibility, speed of responses, empathy, linguistic accuracy), one aspect from a response understanding perspective (understanding), and three aspects from an aesthetics perspective (background color and content, font type and size, button color, shape, icon) (Denecke, 2023). It makes suggestions for tools and heuristics to evaluate these aspects. The framework comprises aspects to be considered not only as part of a system evaluation, but already during the development. We will identify missing aspects to measure and ensure the impact on agency and come up with suggestions for additional metrics based on available literature for extending the framework.

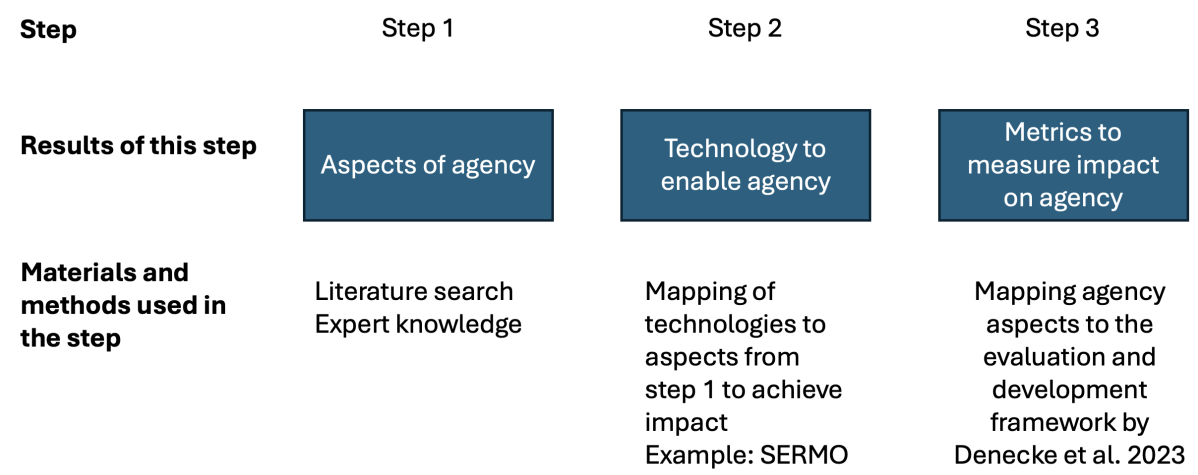

Figure 1: Method to answer our research questions comprising 3 steps

3 Impact of Conversational Agents in Healthcare on Patients' Agency

CAs applied in healthcare contexts, i.e. to deliver health interventions, can impact on patients' agency in several ways. These characteristics (C) of the impact are listed in the following and shown in figure 2.

C1: Improved access to health information and health literacy: Through dialogue, CAs can help improve a patient's understanding of their health condition and treatment options (May and Denecke, 2020). They can be accessible 24/7, providing patients with immediate answers to their questions. They can even guide patients through the decision-making process, providing tailored information to help them weigh up the pros and cons of different treatment options. This constant availability can help reduce the knowledge gap and increase the patient's ability to self-manage health issues in real time.

C2: Personalization and tailored advice: CAs can adapt their responses based on patient input, providing a more personalized healthcare experience. This can empower patients to make informed decisions tailored to their specific needs and circumstances. Even more advanced CAs can provide personalized health advice based on the patient's health records and current health state, which can be more effective than generic information (Kocaballi et al., 2019).

C3: Improved patient engagement: CAs can engage patients more actively in their healthcare journey (Denecke et al., 2020a). They can monitor patient symptoms and provide feedback or reminders, which can help patients understand the implications of their health behaviors (Larbi et al., 2022). By fostering a two-way interaction, CAs can help patients feel more involved and in control of their health decisions. Engaged patients are more likely to be proactive in their care (Barello et al., 2012), which is a critical aspect of agency.

C4: Emotional support and trust: CAs can provide emotional support to a patient, creating a sense of trust and comfort (Meng and Dai, 2021). This can encourage patients to express their concerns more openly, leading to better care and treatment compliance. When offering psychological support, CAs can help patients cope with the emotional aspects of their health conditions, which can be empowering and improve their overall well-being (Denecke et al., 2020b).

C5: Reducing healthcare barriers: For patients with disabilities or those who are less tech-savvy, a CA can be more accessible and easier to use than traditional apps. For individuals in remote areas, those with mobility problems or those who fear stigmatisation, CAs can reduce barriers to accessing health services and advice, thereby increasing the ability of these patients to seek and receive care (Nadarzynski et al., 2021).

4 Example: Emotion regulation with SERMO

In this section, we consider a concrete example of a CA and analyze which functionalities it includes to achieve the various aspects of patient agency.

SERMO is a health CA for regulating emotions and dealing with thoughts and feelings (Denecke et al., 2020b). It implements elements for cognitive

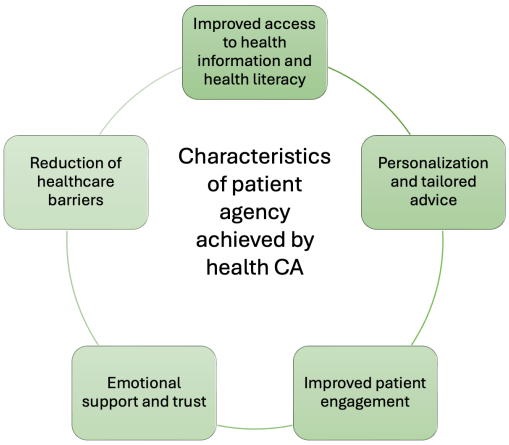

Figure 2: 5 aspects of how CA impact on patients' agency

behavior therapy. Specifically, it asks the user on a daily basis on events that happened and emotions caused by these events. Depending on the emotion, appropriate suggestions are made to the user. SERMO improves access to health information and in this way the user's health literacy (C1). It provides information on the system and its capabilities, but more importantly on cognitive behavior therapy which is the underlying clinical model and explains emotions. Also information on counseling services is provided, however, not by the chat function but by the app in which the CA is integrated.

SERMO is actively collecting information on events and emotions from the user natural language input and analyses them using Natural Language Processing (NLP) techniques and emotion analysis methods. Based on this information, tailored advice is given (C2). Only information explicitly entered by the user is used for this personalization of advice.

Using the mood diary, users can keep track of their emotions and how they handled them. SERMO helps in setting goals and in monitoring the emotions over time. In this way, it supports in understanding their behavior and how to deal with it (C3). The collected information can be discussed with a therapist which contributes to active decision-making and engagement.

A core element of SERMO is the recognition and classification of emotions and provision of appropriate advises. This is realized using NLP and emotion analysis methods. In this way, SERMO provides emotional support (C4). It could be used 24/7 without the need of a therapist or physician, thus helps in reducing healthcare barriers (C5) - however, it has not yet been assessed how SERMO should be used and integrated into care processes. Beyond, it relies only on written text meaning that individuals with visual impairments or limited reading skills would be excluded from using this health intervention.

5 Characteristics of technology to achieve agency

The example provided descriptions of functionalities and technologies that are needed to support patient agency by health CAs. Table 1 maps the agency aspects from section 3 to the technologies required to achieve an impact and evaluation aspects from the health CA development and evaluation framework.

NLP and Natural Language Understanding (NLU) enables CAs to understand and interpret patient input accurately. Such understanding is needed to provide relevant and helpful responses when patients are using a health CA for accessing health information (C1). Additionally correct medical knowledge is required to let a CA provide health information. Eight aspects from the evaluation framework are related to these technological aspects that are relevant to ensure the quality of NLP and NLU including correctness of the provided information. Accessibility and usability of a CA are also essential for improving access to information.

Based on user preferences or user characteristics a CA can tailor advice and information to individual patient needs, preferences, and health histories. Presuming personalization or tailoring techniques are integrated in a CA (C2), CAs can empower patients to make informed decisions.

Health CAs can collect information from the user directly or from integrated sensors and monitoring technology (C3). In this way, the health status can be monitored and shown to the patient together with feedback by the CA. An active reporting of CA-requested health data into the chat (e.g. nutrition information) engages the patient and helps reflecting behavior. Additionally, feedback or reminders given by the CA integrate a patient into the care process. To benefit from this, user engagement is required, an aspect that is already in the evaluation framework.

Sentiment or emotions analysis technologies as well as NLP and NLU technologies are required for enabling a health CA to provide emotional sup-

port (C4). The framework includes three aspects necessary to realize high-level emotional support, namely understanding, empathy and linguistic accuracy. Similar to a patient-doctor relationship, also the patient-to-CA relationship should be characterized by trust. Good understanding of the patient's input by the CA is essential to create a trustful relationship. Additionally, ensuring the confidentiality and security of patient data is essential for building trust and encouraging honest and open communication, reflected by the aspect security in the framework.

An intuitive and easy-to-use interface is crucial for ensuring that patients of all ages, health literacy levels, reading skills and tech-savviness levels can interact effectively with the CA. Providing support in multiple languages as well multiple data entry and output options (e.g. voice recognition and speech-to-text) can enhance accessibility and comprehension for a diverse patient population (C5). We have two aspects in the evaluation framework addressing these factors: accessibility and ease of use.

6 Measuring Patient Agency

In the previous section, we identified aspects from the technological perspective that are prerequisites for achieving an impact on patient agency resulting from the usage of a health CA. However, we can recognize that this technological perspective is missing the human factors' perspective of patient agency. The human factors' perspective rather involves measuring how the interaction with a health CA impacts on a patient's ability to make informed decisions, to manage their health, and to actively participate in their care. To consider this facet also as part of the health CA evaluation and development framework (Denecke, 2023), we suggest to add an additional dimension, called "Human factors Perspective" and collected categories and metrics that can be used to measure impact of health CA usage on patient agency. They are summarized in the following linking them to the 5 characteristics of agency introduced in section 3 and shown in Table 2.

Improved access to health information and health literacy (C1) as well as tailored advice (C2) and patient engagement (C3) impact on health literacy, decision making confidence and self-management capabilities. Accordingly, we identified metrics that allow measuring these aspects: The Decision Self-Efficacy Scale measures the self-confidence or belief in one's ability to make decisions, including participation in shared decision making (O'Connor, 2002). The Health Literacy Questionnaire (HLQ) (Sørensen et al., 2013) assesses a patient's ability to understand health information and make informed decisions. The PAM-13 (Hibbard et al., 2005) measures self-reported knowledge, skill, and confidence for self-management of one's health or chronic condition.

Emotional support and trust (C4) could be considered as patient satisfaction with the treatment (Friedel et al., 2023). Patient-reported outcome measures (PROM) and patient-reported experience measures (PREM) are standard tools for measuring patients' perspectives on the care they receive, the treatment process, and related issues. PROM typically focuses on specific treatment outcomes through questionnaires, such as those assessing health-related quality of life. In contrast, PREM gather insights into patients' experiences of healthcare services and provides direct feedback to healthcare providers. This feedback is used to improve the system and promote integrative care.

Reducing healthcare barriers, i.e. the access to healthcare services is difficult to measure. It could be indirectly measured as health-related quality of life, e.g by SF-36 Hays et al. (1993) or EQ-5D (https://euroqol.org/) assuming that health-related quality of life increases when healthcare services can be accessed. SF-36 or EQ-5D can indirectly reflect patient agency by assessing how health status affects the patient's day-to-day life and perceived control over their health. EQ-5D is a well-known and widely used health status instrument (Devlin and Brooks, 2017). SF-36 (Ware et al., 1996) is a 36-item patient-reported survey of the health status.

7 Discussion

In this paper, we identified possible impacts of CAs in healthcare on patients' agency. They include improved access to health information, tailored advice, improved engagement, delivering emotional support and trust as well as reducing healthcare barriers (RQ1). We aggregated several technological aspects that are prerequisite for achieving these impacts on patient agency. They comprise NLP and NLU, sentiment and emotion analysis techniques integrated in health CAs, access to knowledge sources, personalization techniques, and monitoring technology (RQ2). To evaluate the impact

Table 1: Technology required to achieve an impact on the patient agency as well as relevant technical aspects from the health CA evaluation and development framework (Denecke, 2023)

Agency aspect	**Required technology**	**Aspects from the framework (Denecke, 2023)**
C1	Access to knowledge sources and integrated knowledge, understanding user needs, natural language processing (NLP) and natural language understanding (NLU) technologies	Accessibility, ease of use, content accuracy, linguistic accuracy, understanding, comprehensibility, flexibility, classifier performance
C2	Understanding user input, information on user characteristics and user preferences, personalization techniques	Context awareness, appropriateness of responses, understanding, security
C3	Monitoring technology, sensors, collecting user data, feedback mechanisms / reminders, interpretation of data	Engagement
C4	Sentiment or emotions analysis technologies, NLP and NLU technologies	Understanding, empathy, linguistic accuracy, security
C5	Easy-to-use interface, multilinguality, multiple data entry and output options	Accessibility, ease of use

Table 2: Human factors perspective together with evaluation aspects and metrics to be added to the CA evaluation and development framework (Denecke, 2023) to consider patient agency

Category	**Possible metrics**
Impact on self-management capabilities	Health Literacy Questionnaire (HLQ) (Sørensen et al., 2013), PAM-13 (Hibbard et al., 2005), Decision Self Efficacy Scale
Impact on patient satisfaction with treatment	PROM, PREM
Impact on access to healthcare services	Indirectly measured through health-related quality of life, e.g by SF-36 Hays et al. (1993) or EQ-5D (https://euroqol.org/

of CAs on patient agency, it should be assessed on the one hand whether the required technologies are available and of good quality, which could be realized by considering evaluation aspects of the health CA evaluation framework (RQ3) (Denecke, 2023).

On the other hand, for evaluating the impact of a health CA on the patient agency (RQ3), we identified examples of metrics that could be used to measure the impact of health CA usage on patient agency. For the single aspects such as quality of life or health literacy there exist multiple assessment tools. We only presented some examples of metrics that might be useful. More research is needed on testing whether these metrics and scales are useful to assess the impact of health CA interaction on the agency of a patient.

Our work has been optimistic in the sense that we believe in a positive impact of the use of health CAs on patient agency. However, there could be negative impacts if CAs hinder patient agency. Some examples are described in the following: If a CA's NLP capabilities are limited, it may struggle to understand and respond accurately to complex health queries, reducing its effectiveness and patient trust. Generic, one-size-fits-all responses may be less helpful and fail to address individual patient concerns, undermining patient agency. In previous studies it was found that users often do not know what to ask or write when addressing a health CA (Denecke et al., 2020a) which can be a significant barrier, especially for older or less tech-savvy persons. Providing outdated or inaccurate health information can lead to misinformed decisions, negatively impacting patient health and trust. If a CA cannot access or use existing patient health records, its advice may be less relevant or accurate. Concerns about data security and privacy can deter patients from sharing sensitive informa-

tion, limiting the effectiveness of the CA. A lack of multilingual support can exclude non-native speakers or those with limited knowledge of the CA's operating language. CAs that fail to recognize or respond appropriately to health emergencies can pose significant risks to patient safety (Denecke et al., 2019).

Furthermore, patients may become overly reliant on CAs for health information and decision-making, leading to reduced engagement in their own health management and critical thinking about their health choices. If a CA provides information that is too complex, inaccurate, or not context-specific, patients might misinterpret it. This misunderstanding could lead to poor health decisions. Over-dependence on CAs might lead to reduced interaction with healthcare professionals, which can be detrimental. Human elements like empathy, experience-based intuition, and detailed understanding of a patient's history are critical for effective healthcare. If the algorithms driving the CA are biased, the information and recommendations provided could be skewed, leading to unequal and potentially harmful guidance for certain patient groups. Technical issues like errors in understanding language, limited response capabilities, or system downtime can lead to frustration and reduced patient confidence in managing their health. CAs providing too much information, or information that is not prioritized based on the patient's immediate needs, can overwhelm patients, making it challenging for them to make informed decisions.

In addition, research on health CA has shown that their design, including complexity of responses and persona, significantly influences their effectiveness in providing health information (Biro et al., 2023). However, concerns about accuracy, cybersecurity, and the inability of AI-led services to empathize may compromise patient engagement with CA (Nadarzynski et al., 2019). These examples show that there is a huge need to systematically assess impact of health CAs on patient agency. Our research therefore contributes a first step towards ensuring that health CA have a positive impact on patient agency. Clearly , it is based on experiences and needs validation and extension in future.

8 Conclusions

In this paper, we assessed how health CA can impact on patient agency. By focusing exclusively on patients' agency - rather than that of healthcare professionals - this paper contributes to the growing discourse on patient-centered technology in healthcare, and offers insights and recommendations for the future development and implementation of CA. We conclude that, provided the appropriate technology is chosen, health CAs can have an impact on patient agency, but careful design is needed to achieve such impact and to ensure a positive impact on agency. Typically, studies of health CAs examine their effectiveness in relation to a health outcome or usability. Research is needed to understand which technologies have which effects on agency. Studies measuring the impact on patient agency are still lacking and has to be done in future.

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